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Vitrinite reflectance and Raman spectra of carbonaceous material as indicators of frictional heating on faults

FURUICHI, Hiroyuki[1*] ; UJIIE, Kohtaro[1] ; KOUKETSU, Yui[2] ; SAITO, Tsubasa[1] ; TSUTSUMI, Akito[3] ; WALLIS, Simon[4]

[1]University of Tsukuba, [2]The University of Tokyo, [3]Kyoto University, [4]Nagoya University

Vitrinite reflectance (R_o) and Raman spectra of carbonaceous material (RSCM) have been used as geothermometers to estimate maximum temperature recorded in sedimentary and metamorphic rocks. We experimentally examined whether these geothermometers can be applied for the detection of temperature increases associated with fault slip. Friction experiments were conducted on a mixture of powdered clay-rich fault material and carbonaceous material (CM) at slip rates of 0.15 mm/s and 1.3 m/s in nitrogen (N_2) gas with or without distilled water. After the experiments, we measured R_o and RSCM and compared to those in starting material. The results indicate that when fault material suffers rapid heating and comminution in ˜9 seconds at 1.3 m/s, R_o and the intensity ratio of D1 and D2 Raman bands of CM (I_{D2}/I_{D1}) markedly increase. Comminution with very small temperature rise in ˜32 minutes at 0.15 mm/s is not responsible for changes in R_o and I_{D2}/I_{D1}. Our results demonstrate that R_o and RSCM can be useful for the detection of frictional heating on faults. However, the conventionally used R_o and RSCM geothermometers are inadequate for the estimation of peak temperature during seismic fault slip. The reaction kinetics considering rapid heating and comminution at high slip rates and the investigation of original microtexture and composition of CM are required to establish a thermometer of friction heating on faults.

Keywords: frictional heating, vitrinite reflectance, Raman spectra, carbonaceous material, friction experiments